Aerosol Collector Efficiency Characterizations at the Edgewood Chemical Biological Center

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Standard Form 298 (Rev. 8-98)
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Introduction

- Harmful Aerosols
  - BW agents are aerosols
  - Workplace aerosols (toxic and high concentration)
  - Environmental aerosols
- Different samplers for different purposes
  - High volume samplers – to collect maximum # of particles from air
  - Representative sampler – unbiased sample – proportional to distribution in air

- Aerosol collector is a critical component of the CB Point Detection System
- A high volume sampler extracts and concentrates aerosol samples from the surrounding environment
- Characterizing performance of a sampler is important to assess system effectiveness and to choose an appropriate sampler for the situation
- Ideal sampler
    - High sampling efficiency and Concentration Factor
    - Low weight
    - Low power consumption
    - Collection media compatible with detection schemes

- Sampler components
  - Inlet (omni and uni directional)
  - Transport tube – precollectors, concentrators, tubes, bends
  - Collection site (filter, cyclone, impaction surface)
- Overall sampling efficiency = Ratio of particles collected to particles in the environment
- Overall sampling efficiency is the product of the efficiency of each component
- Individual component efficiency will indicate where design problems exist and where improvements can be made

- Testing for efficiencies
  - Wind tunnel testing – inlet aspiration efficiencies
  - Chamber testing – sampler at calm air condition
  - Flow through cell testing – sampler component testing (example: ducts)

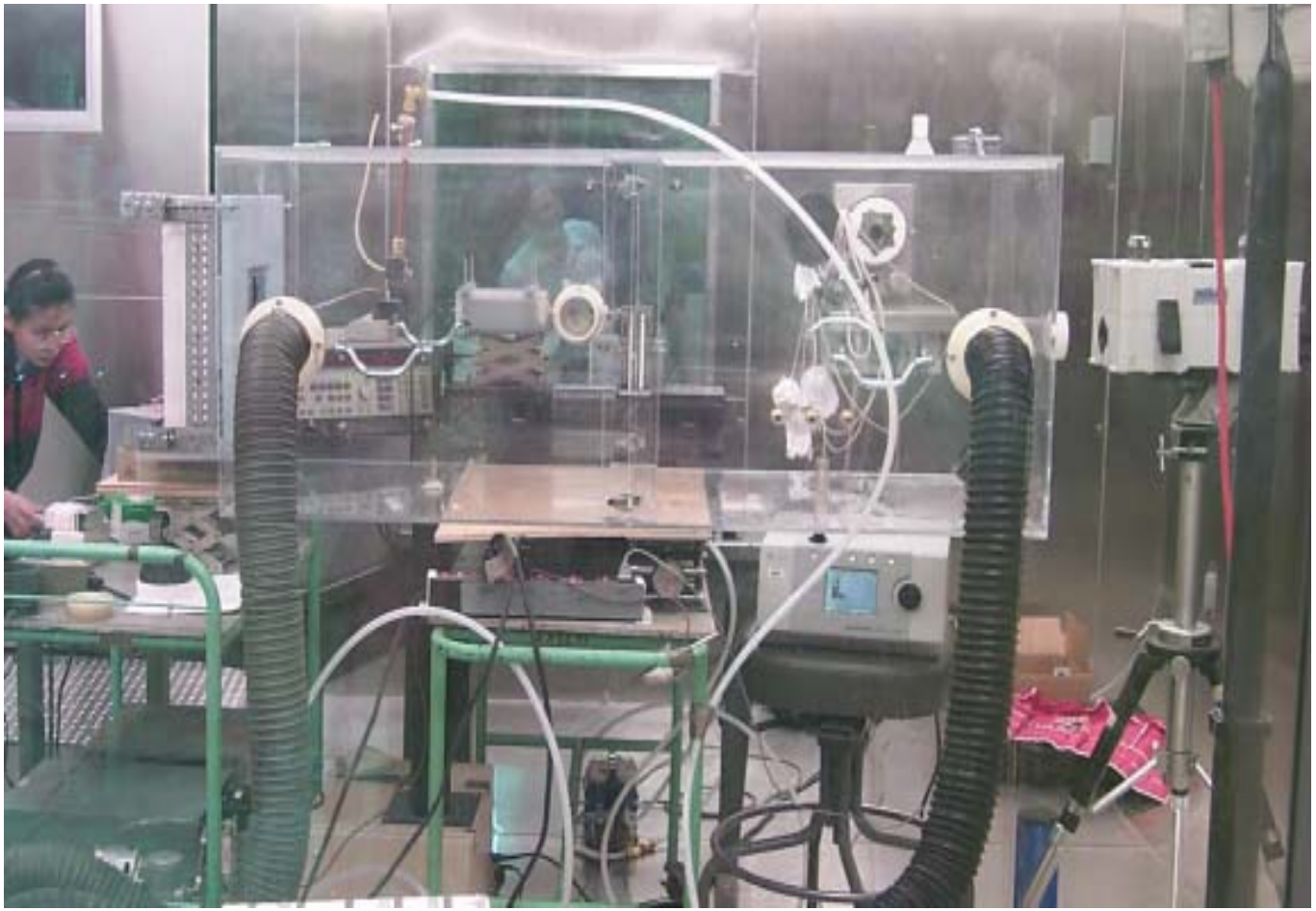
Aerosol Chamber

- 70 m^3 environmentally controlled stainless steel chamber
- Temperature and humidity are controlled in the chamber
- Air entering and exiting the chamber are filtered by HEPA filters
- Wash down capability
- UV lights to kill biological materials
- Computer controlled power receptors
- Mini chambers are placed inside for special tests

Aerosol Chamber

Aerosol Chamber

Aerosol Chamber

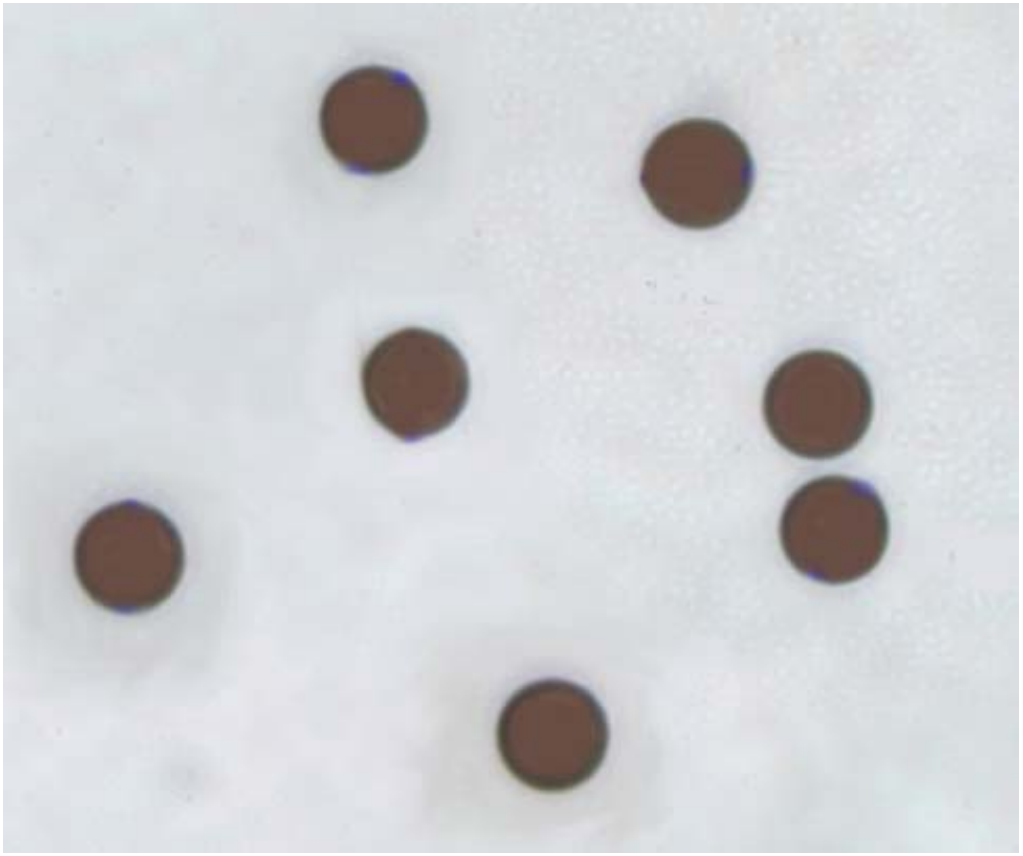


Typical aerosol challenges used in ECBC chambers and wind tunnels

Aerosols	Generation Method	Size Distribution	Analysis Method	Comment
PSL	Nebulizers, Sonic nozzle, IJAG, puffers	Monodisperse	Microscopy, Fluorometry Coulter Counter	Expensive Membrane filters
Fluorescent oleic acid droplets	VOAG Spinning top Aerosol generator	Monodisperse	Fluorometry	
Test dust Al_2O_3	Sonic nozzle	Poly or narrowly dispersed	Gravimetric Coulter Counter	
Biosimulants	Nebulizers, IJAG, sonic nozzle, bubbler	Poly, mono or narrowly dispersed	Culturing Coulter Counter APS	Survivability of Biosimulants

- Liquid particles – monodisperse fluorescent Oleic acid aerosols
  - VOAG
  - Neutralized
  - Aerosol generation for 10 min, mixing in the chamber for 30-60 seconds, and sampling for 10 min
- Analysis using fluorometry
  - Suitable excitation and emission filters
  - pH between 8 – 10
  - All samples must be at the same temperature

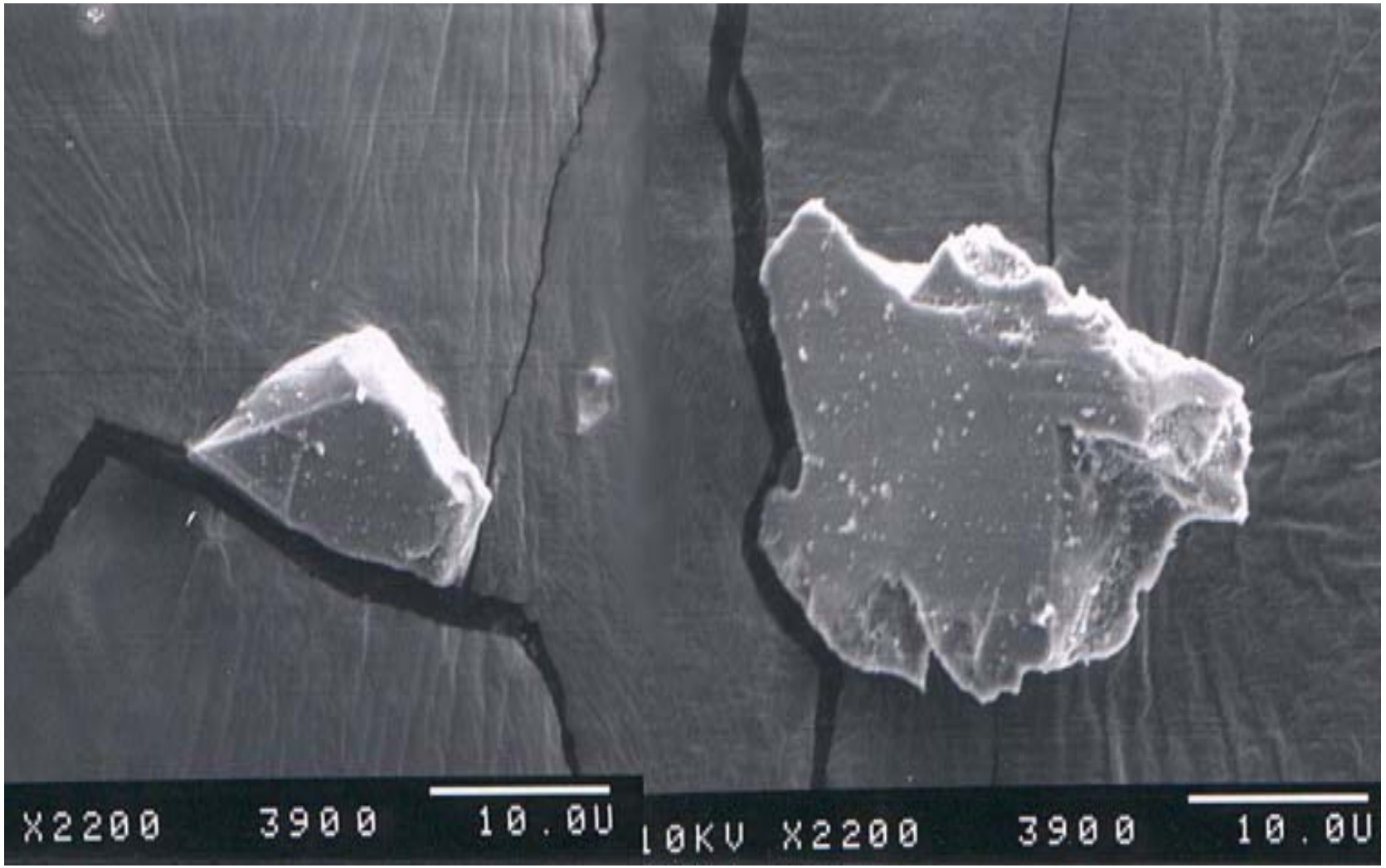
Fluorescent Oleic Acid Droplets



- Solid particles – polydisperse Al_2O_3
  - Sonic nozzle
  - Not-neutralized
  - Aerosol generation in 15 – 30 sec, mixing in the chamber for 1 min, and sampling for 10 min
- Analysis is using Coulter counter
  - Solid
  - Particles must be insoluble

Sonic Nozzle

Al_2O_3 Particles

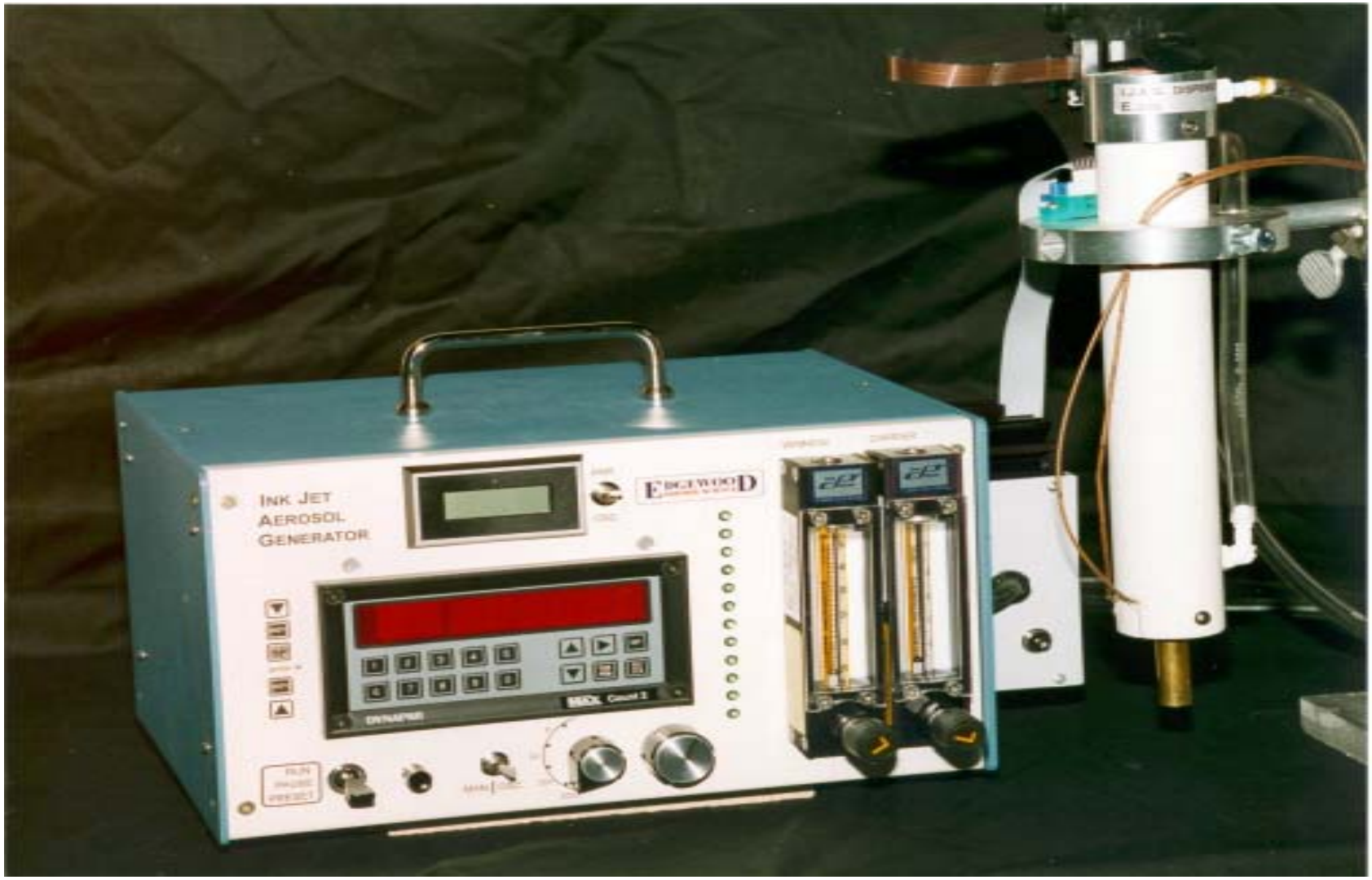


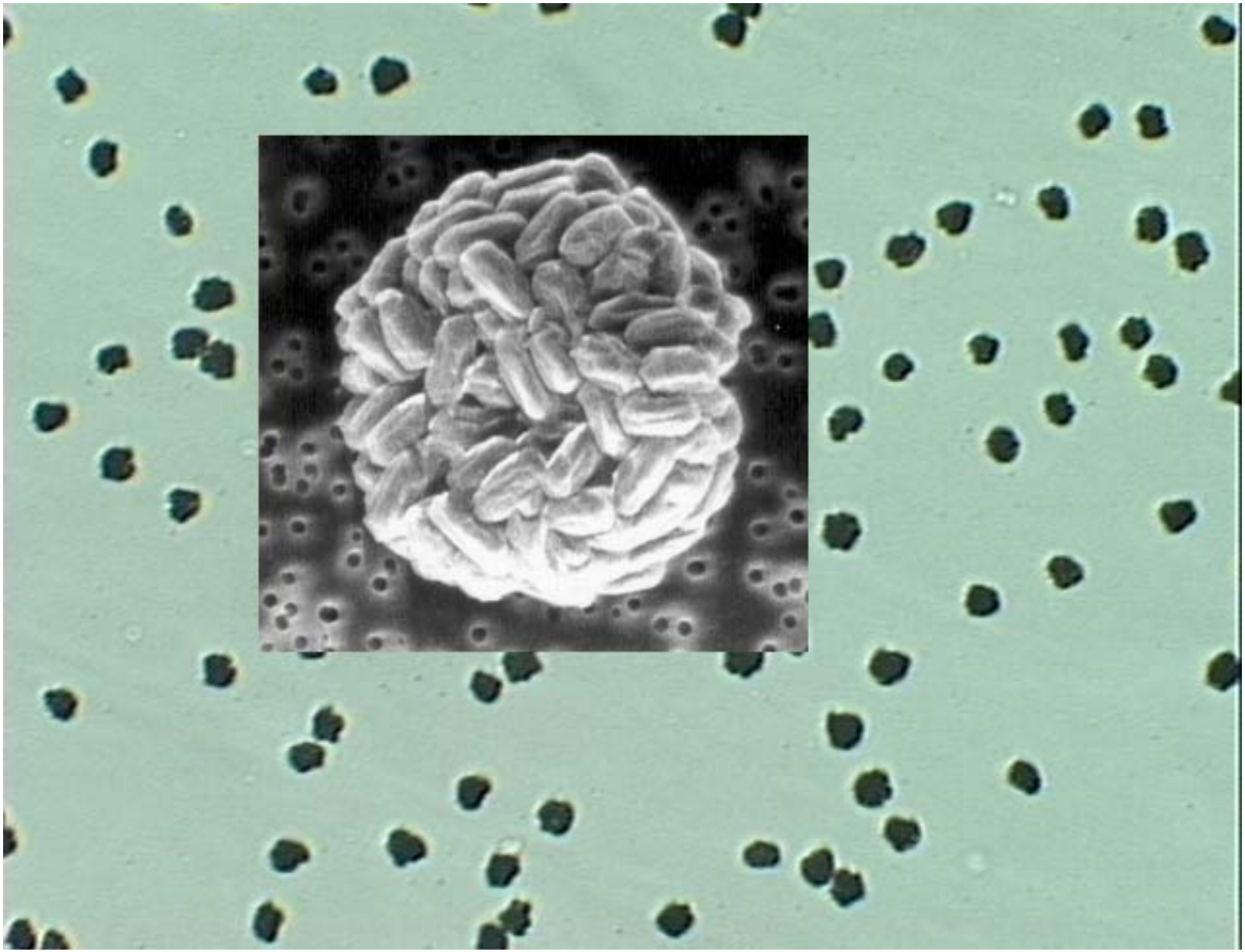
Solid particles – PSL

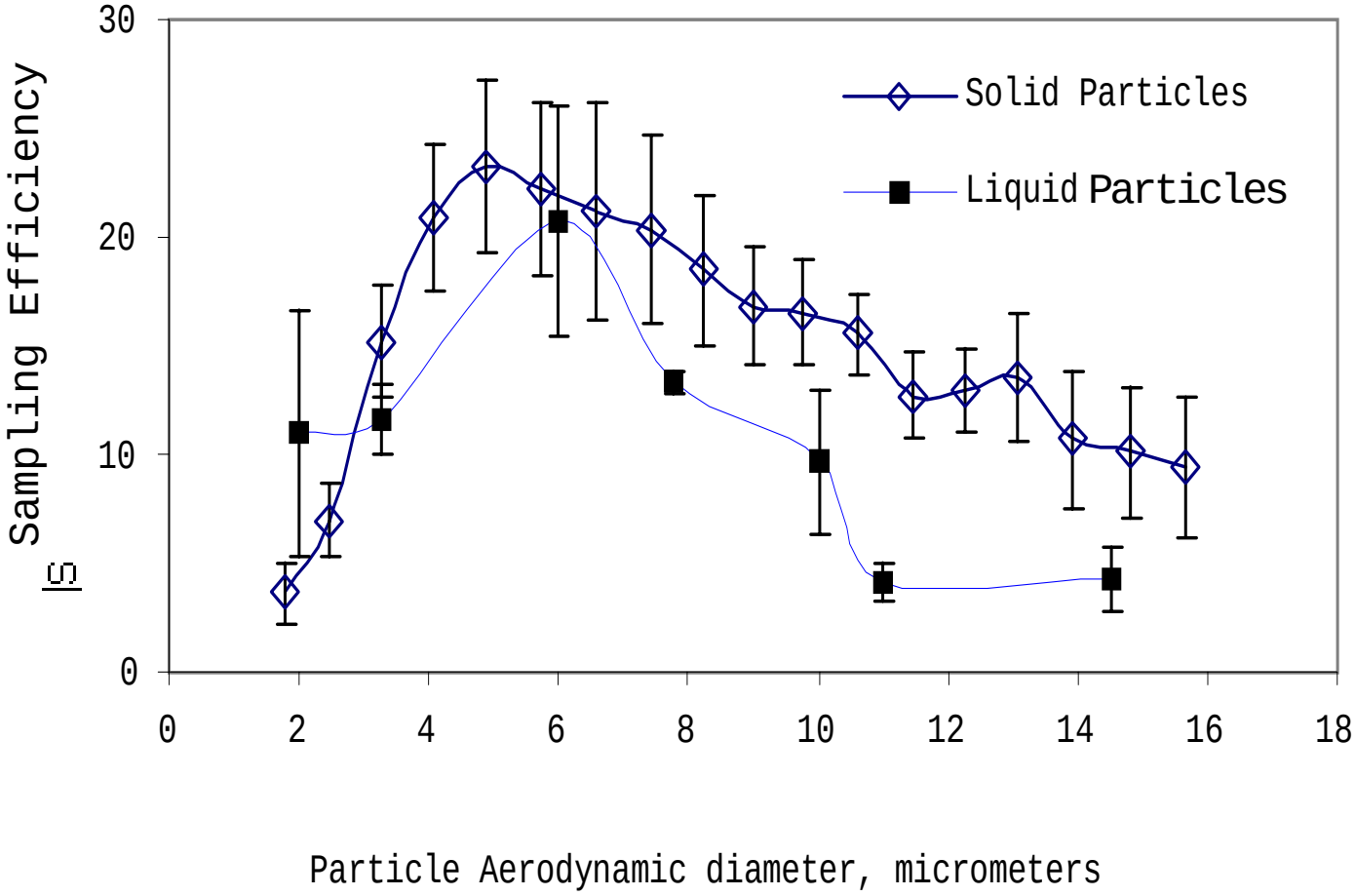
- Generation
  - Generated using 36 jet collison nebulizer and sonic nozzle
  - Neutralized
  - Generated 0.5, 1, 2, 5, and 6 micron blue or green fluorescent particles
- Analysis using a fluorometer
  - Use appropriate excitation and emission filters to detect blue or green
- Analysis using a Coulter counter
  - Install appropriate orifice tubes to measure small particles

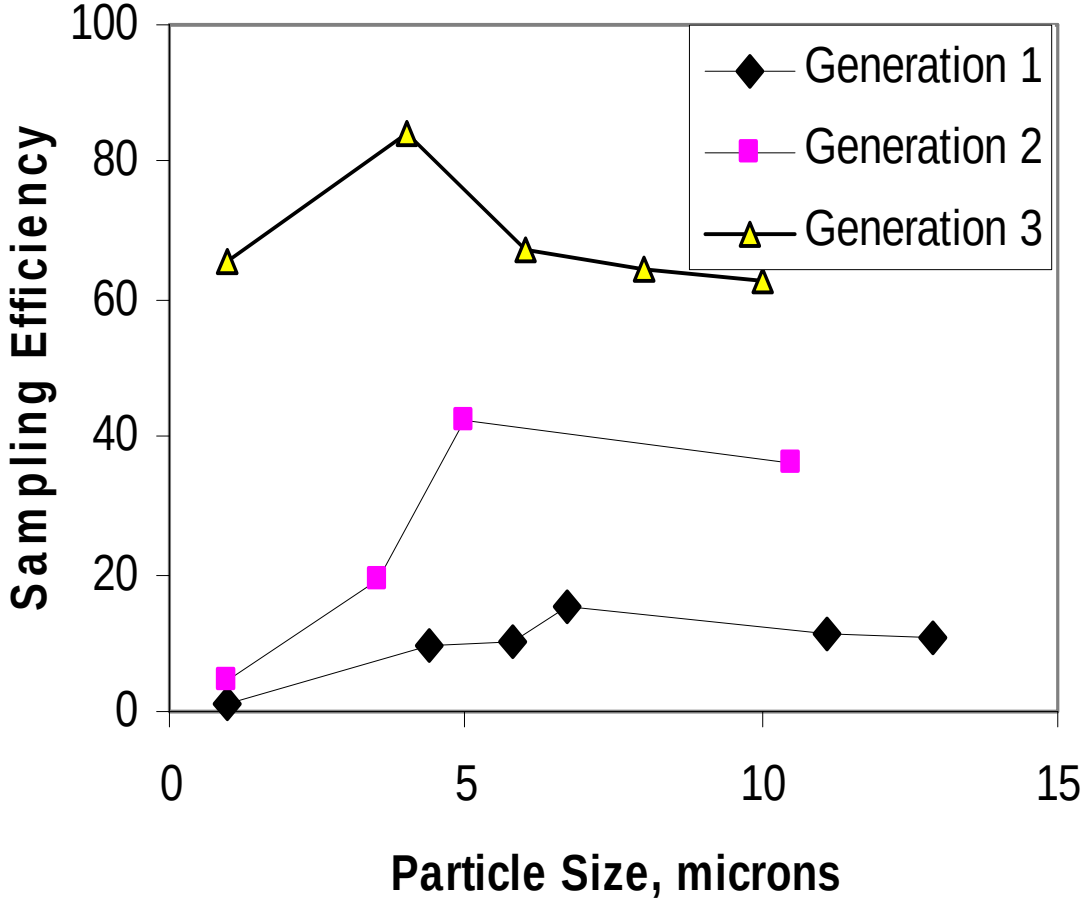
Bg and Yeast extract

- Generated using puffers, bubblers, nebulizers, sonic nozzles and IJAG
- Analysis by APS, culturing, PCR, and Coulter counter method


INK JET
AEROSOL
GENERATOR
EDGEWOOD

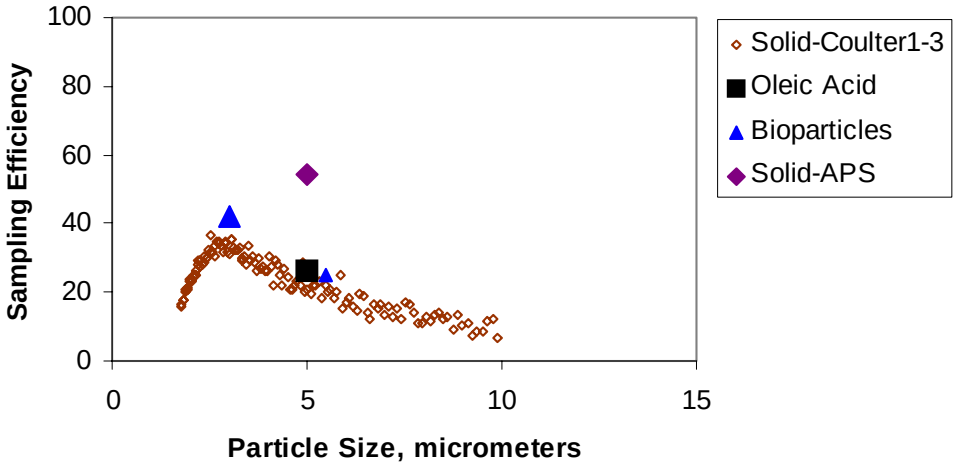



Sampling Efficiency
(S)
30
20
10
0
0
2
4
6
8
10
12
14
16
18
Solid Particles
Liquid Particles
Particle Aerodynamic diameter, micrometers


100
80
60
40
20
0
Sampling Efficiency
0
5
10
15
Particle Size, microns
Generation 1
Generation 2
Generation 3

XMX/2A

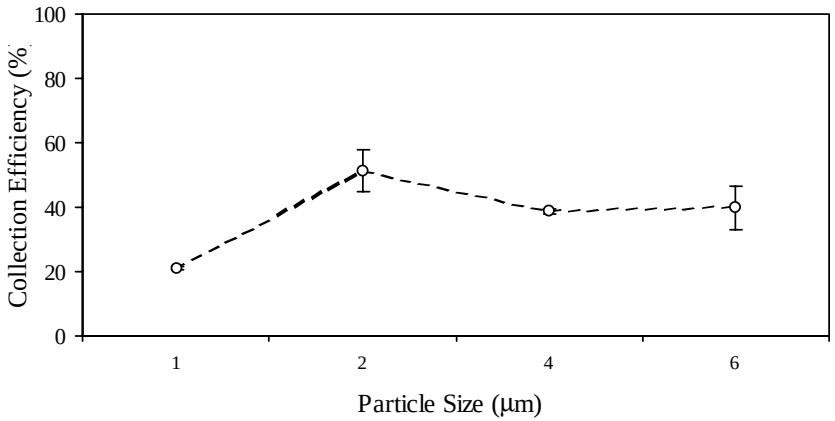
XMX/2A



Characteristics	
Air sampling rate (L/min) Minor air flow (Inlet) (L/min)	742 0.4
Dimensions (inch) Size Length Width Height	 8.5 18 18
Weight (lb, oz)	24, 12
Power, Watts Voltage, Volts Current, Amp	780 115.6 6.99

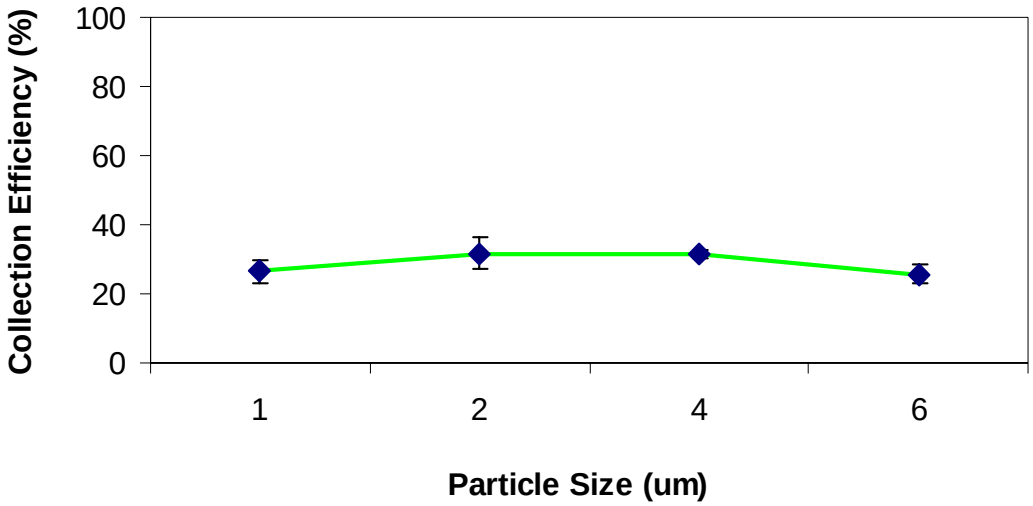
BioGuardian® 1.02

	BioGuardian® 1
Number of Cyclones	1
Designed air flow rate (L/min)	90
Measured air flow rate (L/min) (measured at ECBC)	88
Power, measured at (Watt) (measured at ECBC)	57.5
Weight (lbs)	17
Dimensions (inch)	Length = 11 ¾ Width = 11 . Height = 17 ¼
Sample Volume, (mL)	7.7 ± 0.5

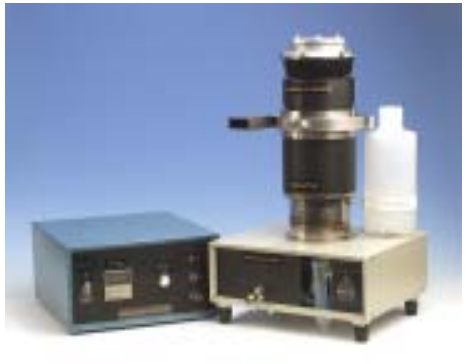


BioGuardian® 12.02

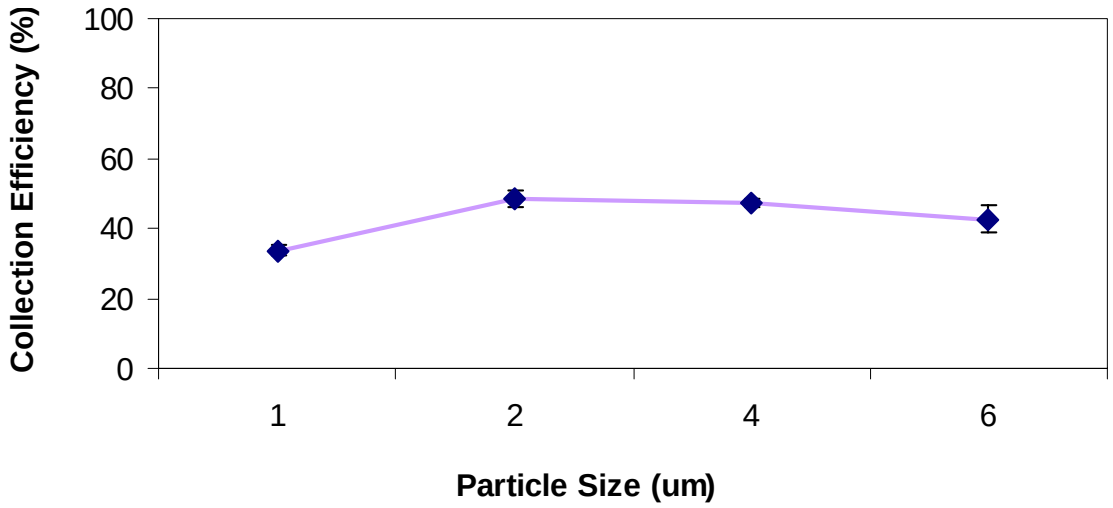
	BioGuardian® 12
Number of Cyclones	12
Designed air flow rate (L/min)	1100
Measured air flow rate (L/min) (measured at InnovaTex)	1000
Power, measured at (Watt) (measured at ECBC)	421
Weight (lbs)	>75
Dimensions (inch)	Height = 25 Diameter = 14.5
Sample Volume in 10 min, (mL)	12.6 ± 2.3



BioGuardian® 4.02

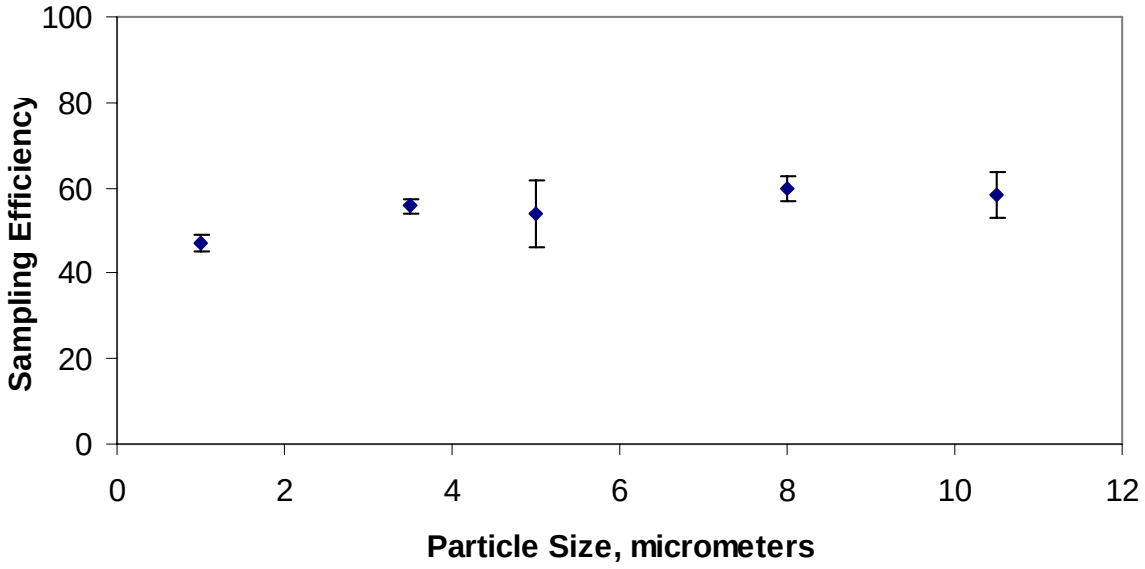


	BioGuardian® 4
Number of Cyclones	4
Designed air flow rate (L/min)	350
Measured air flow rate (L/min) (measured at ECBC)	350.9
Power, measured at (Watt) (measured at ECBC)	137
Weight (lbs)	32.5
Dimensions (inch)	Length = 12 Width = 10 . Height = 18
Sample Volume in 10 min, (mL)	11.6 ± 1.3



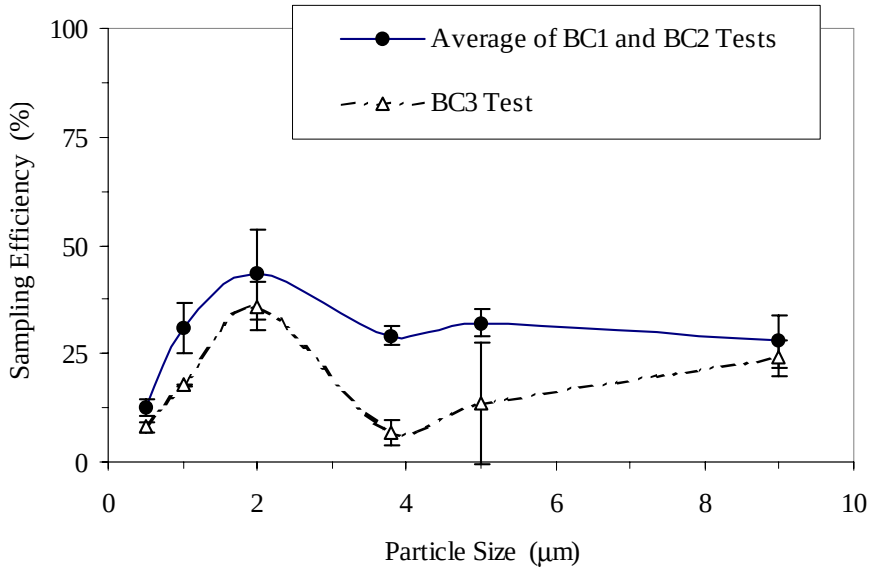
Microvic™ Aerosol Concentrator

Air sampling rate: measured, L/min	30
Overall dimensions, inch	
Length, inch	2
Width, inch	2
Height, inch	2.5
Weight, lb	11/16
Power consumption	Lab pumps were used



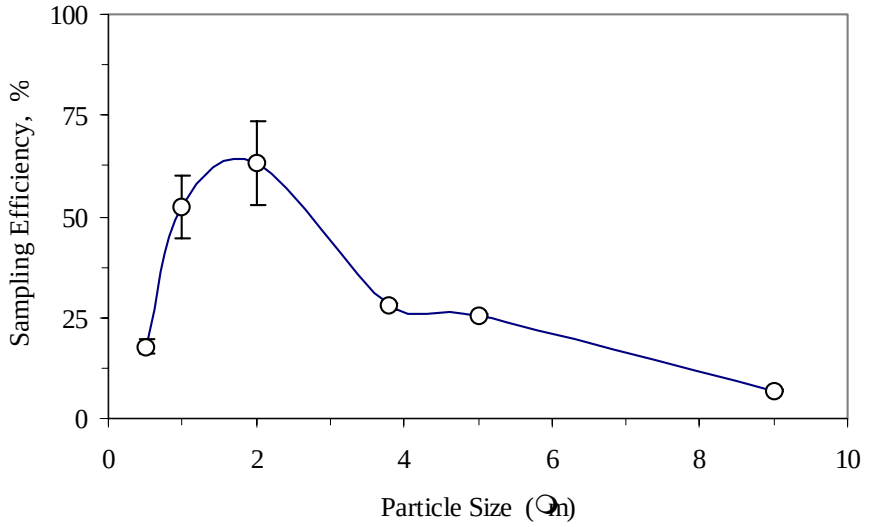
BioCapture™ BT-550 Aerosol Sampler

Measured air sampling rate, L/min	150
Overall dimensions, inch	
Length	12
Width	6
Height	8
Power, W	Battery operated
Weight, lb	10



MicroVic® Aerosol Concentrator

Measured air sampling rate, L/min	423
Overall dimensions, inch	
Length	19
Width	9
Height	29.5
Power consumption, W	323
Weight, lb	24.7



PHTLAAS Air Sampler

Air sampling rate,, L/min	317
Sampling time, min	10
Liquid volume input, mL	50
Average liquid volume output (± std dev), mL	35.3 ± 3.5
Power, Watts	85.3
Voltage, Volts	123.6
Current, Amps	1.1
Particle Size (µm)	Sampling Efficiency (%)
	65.7 ± 3.0
1	84.3 ± 4.2
4	67.5 ± 3.7
6	64.3 ± 4.6
8	62.5 ± 1.9
10